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(71) Applicant(s): AUTOMOBILES PEUGEOT
75, avenue de la Grande Armée
F-75116 Paris (FR)

AUTOMOBILES CITROEN
62 Boulevard Victor-Hugo
F-92200 Neuilly-sur-Seine (FR)

(72) Inventor(s): Andre, Georges
90 rue des Cantons
F-25400 Audincourt (FR)

Gerard, André
5, rue de Gerbevilliers
F-25400 Audincourt (FR)

(74) Attorney or Agent: Kohn, Philippe et al.
c/o Cabinet Lavoix
2, place d'Estienne d'Orves
F-75441 Paris Cedex 09 (FR)

(54) Composite structure frame and method of production

(54) This composite structure frame, comprising reinforcing fibers impregnated with thermoset resin, is characterized by the presence of a central core (9) of cellular material forming a closed loop and enclosed in a sheath (10) formed of several layers of continuously woven and resin impregnated fibers. The method for producing this frame consists in realizing a semi-finished product that has a central core (9) forming a closed loop of flexible cellular material and a flexible sheath (10) of continuously woven fibers enclosing the core in several layers, placing this semi-finished product in an appropriate cavity of a heated mold, injecting a thermoset resin into it, and hardening said resin.

[illustration]

FIG.19

Description

Composite structure frame and method of production

The present invention relates to a composite structure frame comprising reinforced fibers impregnated with thermoset resin.

More particularly, the invention relates to the production of lightweight rigid frames, primarily designed to enclose a panel, such as that of an automotive vehicle window or door, or to form a seat frame or rollbar.

Based on the current state of the art, we are familiar with injection-molded parts reinforced with fiberglass or carbon, parts made by compression of polyesters impregnated with such fibers, or parts made by pultrusion of fibers impregnated with thermoset resins.

However, such procedures are often relatively incompatible with the production of parts in the shape of a thin frame, and their resistance is often inadequate because of the random shape and placement of fibers contained in the composite material.

Some frames have been made from a profile that follows a closed loop, but this loop is closed either by superposition of the two end segments of the profile or by using an unreliable joint at the end of these segments.

Suggestions have also been made, for example, in document JP-A-60 222 235, for a composite steering wheel comprising reinforced fibers impregnated with thermoset resin and a central core forming a closed loop made of a cellular material enclosed in a sheath formed of several layers of continuously woven fibers impregnated with resin.

Nonetheless, such a structure is not really suitable for producing frame-shaped elements designed primarily to enclose a panel.

To resolve this problem and obtain a frame that is light and has high resistance, the invention proposes a composite structure frame comprising reinforced fibers impregnated with thermoset resin, of a type consisting of a central core forming a closed loop of cellular material enclosed in a sheath formed of several layers of continuously woven fiber impregnated with resin, characterized in that the width of the sheath is greater than that of the core, and the cross-section of the frame comprises a portion of sheath enclosing the core and at least one other portion of the sheath flattened onto itself.

According to another aspect of the invention, the object is a method of production of a frame as defined in claim 1, characterized in that a semi-finished product is realized, which consists of a central core forming a closed loop, made of flexible cellular material, and a flexible sheath made of continuously woven fibers enclosing the core in several layers. This semi-finished product is placed in the cavity of a heated mold whose shape and cross-section correspond to those of the frame we wish to produce. Into this is injected a thermoset resin and said resin is hardened. A semi-finished product is produced by completely sliding over the central core, whose ends are free, a flexible sheath of woven fibers at least twice as long in its free state as the central core. The two ends of the core are assembled either by welding or gluing to form a closed loop. The sheath is then slipped over itself by sliding one of its ends around the other for the full length of the core.

The invention can be better understood with the help of the following description, provided solely as an example, which refers to the attached drawings, in which:

- Fig. 1 and 2 represent an embodiment of a frame for a door structure of an automotive vehicle;

- Fig. 3 to 7 represent different cross-sections of the frame according to the invention;

- Fig. 8 and 9 represent, respectively, a surface view and cross-sectional view of an initial embodiment of a semi-finished product for a frame according to the invention;

- Fig. 10 and 11 represent, respectively, a surface view and cross-sectional view of a second embodiment of a semi-finished product for a frame according to the invention;

- Fig. 12 to 19 illustrate different steps in the production process of a semi-finished product for a frame according to the invention.

As shown in Fig. 1 and 2, a frame according to the invention is, for example, intended for use as a support structure 1 for a door of an automotive vehicle. This structure consists, for example, of a nearly rectangular cross-section 2 and a portion 3 possessing recesses designed to accept, for example, weather seals for doors. However, the frame according to the invention, may also present other cross-sections, such as those shown in Fig. 3 to 7, for example, in which round and square cross-sections can be seen, but which can also be oval or hexagonal. This frame is formed from a semi-finished product and two embodiments are shown in Fig. 8, 9 and 10, 11, respectively.

Thus, for example, in Fig. 8 and 9, the semi-finished product comprises a central core 4 of flexible cellular material onto which a flexible sheath 5 of continuously woven fibers is arranged, enclosing the core in several layers.

Thus, in these figures, the sheath 5 encloses the core 4 three times, and the cross-section and dimension of the core are nearly equal to those of the sheath.

In Fig. 10 and 11, however, the core 6 has a square cross-section whose dimension is clearly less than the width of the sheath 7, which here wraps around the core four times. The semi-finished product used to produce the frame according to the invention is realized, as shown in Fig. 12 to 19, by completely inserting over a central core 9 of flexible cellular material whose ends are free, a flexible sheath 10 of woven fibers whose length in its free state is, for example, at least equal to twice that of the core (Fig. 12). This sheath is then wrapped (Fig. 13) around the core in such a way that the two ends of the core are free and can be assembled, for example, by welding or gluing, as shown in Fig. 14, in such a way as to form a closed loop. The sheath is then slipped over itself, as shown in Fig. 15 to 19, in such a way as to enclose the core 9 in several layers.

It should be noted that the length of the core 9 is equal to the average length of the perimeter of the composite frame realized and the length of the woven fiber reinforced sheath is preferably a multiple of the length of the perimeter of the composite frame to be realized, so that a number of enclosing layers of woven reinforcing material are created, calculated to satisfy the specifications for the frame being made. Thus, during these operations, one of the ends of the sheath is slipped over the other end, which remains immobile on the core. This operation is continued throughout the length of the core, while lengthening the part of the sheath previously compressed until the two ends of the sheath are joined, for example, at the point of assemblage of the two ends of the core.

The woven fiber reinforced sheaths can, for example, be made of fiberglass or carbon, aramid or mixed fibers, or polyester, polypropylene, etc. The braid angle of these fibers can be between 0 and 60°.

The central core, whose role is to facilitate the ability to slide the sheath over itself to obtain the various woven reinforcing layers and lighten the thick sections of the profile, is made of ribbons of various cross-sections, as mentioned above, made of a light, malleable, flexible material, such as, for example, expansible thermoplastic foam (PVC, polyolefin, polyurethane, etc.) or thermoset resin (epoxy, polyester, etc.), impregnated with low density material (wood flour, etc.).

The semi-finished product thus obtained is then arranged in an appropriate cavity of a heated mold, for example, at 120° degrees, whose cross-section and shape correspond to those of the frame we wish to obtain. After the mold is closed, a reactive resin with good thermosetting properties (epoxy resin, vinylester, polyester, etc.) is injected into the semi-finished product and said resin is hardened to obtain the frame.

It should also be pointed out that in certain cases, and as shown in Fig. 2, 5, 6, 7, 10, and 11, the width of the sheath is greater than that of the core, so that the width of the frame may comprise a portion of sheath enclosing the core and at least one other portion of sheath flattened against itself in such a way as to constitute, for example, the edges of the recesses restricted to the portion 3 of the frame shown in Fig. 2.

Claims

1. Composite structure frame comprising reinforcing fibers impregnated with thermoset resin, of a type having a central core (4, 6, 9) forming a closed loop of cellular material, enclosed in a sheath (5, 7, 10) formed of several continuously woven fiber layers impregnated with resin, characterized in that the width of the sheath (7) is greater than that of the core (6), and in that the width of the frame (1) comprises a sheath portion (2) enclosing the core and at least another sheath portion (3) flattened against itself.

2. Method for producing a frame as defined in the preceding claim, characterized in that a semi-finished product is realized having a central core (4, 6, 9) forming a closed loop of flexible cellular material, and a flexible sheath (5, 7, 10) of continuously woven fibers, enclosing the core in several layers, which semi-finished product is placed in a heated mold whose shape and cross-section correspond to those of the frame we intend to realize, and a thermoset resin is injected into it and said resin hardened, and in that the semi-finished product is realized by fully covering the central core (9) whose ends are free in a flexible sheath (10) made of woven fibers that is at least twice as long in its free state as the core, and assembled by welding or gluing the two ends of the core to form a closed loop, then fitting the sheath over itself by slipping one of its ends around the other for the entire length of the core.

[Three pages of drawings follow in original. Trans.]